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When Teachers Go to Camp

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Biology Clubs and Projects

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COVER PHOTOGRAPH

Raccoon from an Ektachrome transparency, taken by John Stemen, Goshen, Indiana, who is field auditor for the State of Indiana and enjoys nature photography as an avocation. The raccoon is a regular evening visitor to a bird feeder fastened on the outside of a window.

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When Teachers Go to Camp

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Author's Note: In the summer of 1954, the author cooperated in developing and teaching a new course called "Outdoor Education." The course was offered in a camp setting at the Lorado Taft Field Campus at Oregon, Illinois. This is a branch campus of Northern Illinois State Teachers College.

The course gave senior or graduate credit and was limited to those who had teaching experience. It was designed to promote outdoor education, especially through the medium of school camping.

There were skeptics among those teachers and principals who entered camp on a fine June morning. What was this thing called "Outdoor Education"? Would the course be worthwhile? Or maybe too much work for the credit? Would they have to "rough it"? Perhaps sleep on the ground and bathe in the river?

Some came to look around; they remained to enjoy the whole scope of the program. What did they find? First of all, a camp in the woods—the former Eagle's Nest Camp of the famous sculptor, Lorado Taft. Located on a bluff near the Blackhawk Statue, it overlooks the beautiful Rock River above the town of Oregon.

They found comfortable living quarters in a modernized cottage, enjoyed delicious food in a spacious dining room, and relaxed in the friendly atmosphere of the Taft cottage.

The second discovery of the teachers who came to camp was the staff—a group of friendly, capable teachers from Northern Illinois State Teachers College. There were specialists in various areas—school camping, elementary education, biology, earth science, and recreation.

With the help of the staff members, the students began to understand the scope and content of outdoor education. They found that it is a new trend in education—a procedure of extending the classroom into the out-of-doors. This is usually accomplished by taking the children out of a classroom to a campsite where they live with their teacher for several days in an outdoor setting.

Living together, teacher and pupils really discover each other. They work and play together and develop a rapport that is seldom possible in the classroom. They discover that they can investigate and understand many things in the out-of-doors that cannot be studied in the classroom.

The activities of the three-week period for the course, "Outdoor Education," were many and varied. Field studies were conducted daily. These were planned cooperatively by the staff and students. Trips were taken to study earth history and structure, mineral resources, soil content, conservation practices, life of a pond, plants and animals of woods and prairies, and local history. Observations were made of weather phenomena, the sun, moon, planets, stars, and the nocturnal activities of organisms in the woods.

There were discussions of the nature of outdoor education and its place in various levels of the curriculum. Motion pictures and slides of programs in action were seen. Time was allowed for students to explore the library facilities for information to meet their individual needs. Staff members were available for conferences during unscheduled time.

Recreational activities were planned by class members. What did they choose to do? Aquaria and terraria were set up and stocked with organisms from the area. Several types of outdoor cookery were tried. Handicrafts with natural materials were popular. Some enjoyed swimming. Evening activities included music, folk dancing, and an Indian ceremonial.

When the three-weeks course was over, how did the participants react? They were reluctant to have it end. They had developed friendships they valued highly. They were instilled with

Group at Lorado Taft Field Campus.

a keen enthusiasm for outdoor education. They had discovered its full meaning through experience, and each was eager to use the newly-found principles in his own teaching situation.

Here are typical reactions to the camping experience:

"I was at a loss as to what to expect when arriving at camp. It was the liberal, free way I was accepted which makes me so enthusiastic about an outdoor education program. It is the thing I want others to experience, and children especially, before they get completely confused about things with which they have had no first-hand experience."

"Now that the course is completed, my understanding of outdoor education is that it is an experience in the out-of-doors whereby the children learn practical applications and uses for subject matter. They also learn the relationships that exist between all things."

"One of the most valuable experiences has been the discussing of the various trips, projects, and experiences. These discussions have given all of us a better understanding of our experiences and a broader outlook and understanding of the different interpretations people have of the same experience."

"Some of the things I learned to do have given me a feeling of security."

"I have learned far more about the out-of-doors than I expected."

"I have gained a deeper insight into the common things. I did not know how to observe! I have been given much help on how to really look."

"My ideas have been drastically changed. I am convinced that direct learning while the interest is high really sticks. Here one can use the various senses to make the learning situation real."

"The friendships I have made and the working and planning together have shown me quite a new way to work and play with children. I believe I will be able to go back to the schoolroom and do a much better job than I have done before."

The members of the staff feel that the course "really clicked." They are looking forward to the summer of 1955 when "Outdoor Education" will again be offered on the Lorado Taft Field Campus at Oregon.

The invisible killers in great, death-dealing smogs appear to be tiny particles of acidic salts metallic ammonium sulfates that dissolve in the fluids of the respiratory tract and cause acute irritation of the surrounding tissues, a chemical engineer recently told the American Chemical Society at its 126th national meeting in New York.

A group of sixth grade pupils plans its program with camp counselors during a week of school camping. They are on the porch of the dining hall.

A typical outdoor activity. A group is investigating tree growth with an increment borer. I am second from the left. I do not usually have my tongue out.

Although most activities are out-of-doors, there are times when students and instructors talk things over indoors.

The Inductive Method in the Biology Laboratory

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This article is the second in an effort to answer a query to one of the senior author's articles[1], the query being, "Well, it's easy enough to point out what's wrong with the teaching of biology. Why don't you suggest how to do it right?" The first effort to suggest a right way appeared in the May 1954 issue of *The American Biology Teacher*[2]. Perhaps these efforts will stimulate others to suggest right ways.

In general, the viewpoints that motivated this article have been expressed many times at the conventions of the National Association of Biology Teachers, as well as in many journals. Two of the more important ones are these:

1. Laboratory work in biology does not seem to involve problem-solving procedures. The students seem to spend most of their time observing and making illustrations of specimens. When later they are tested, the meanings and understandings considered to be objectives of the laboratory work are woefully lacking.

2. Students do not seem to have "psychological ownership" of the information they obtain from laboratory work. For example, a vast number are quite capable of glibly reciting the characteristics of certain plant phyla or species. Yet when given a specimen of a certain phylum or species they are unable to identify it.

Indeed no one person has all the answers for solving these problems, nor do the authors presume to have even one. However, in view of the original query, they will attempt to make certain suggestions for an inductive approach to the biology laboratory that may help solve some of the problems in the viewpoints stated above.

1. *Dispense with All or Most All Experiments Found in Laboratory Manuals.*

a. "Problem: To Study and Dissect the Crayfish;" "Problem: To Discover the Differences between the Monocot and Dicot Stems;" "Problem: To Study the Animal Cell;"—so go the typical cookbook exercises! These are *not* problems—they are merely statements of types of exercises in which the students will be more or less *forced* to participate. A problem does not exist unless the student is aware that he has a situation in which he must search for answers. It is most doubtful whether any of these meet this criterion.

b. "Place the frog on its back and pin all appendages to the dissecting wax. Using your scissors, make an incision from the posterior end of the abdomen to the anterior. Make perpendicular incisions at the ends of the original incision. Fold back the tissues thus cut, and pin to the wax. You have now exposed the internal organs."

To assume that such activity makes an *investigator* out of a student is tantamount to admitting that anyone who can slice bologna is a butcher.

c. "Examine the internal organs of the frog. Compare them with the diagram below. Label the parts of the diagram."

How anyone can remotely assume that the examination of the "innards" of a frog will enlighten the student with respect to the names of the inner parts is difficult to imagine. Yet "experiment" after "experiment" is thus

[1]Mallinson, George Greisen, "Knowledges of Botany Possessed by High School and College Students." *The American Biology Teacher*, XV (October, 1953), 151-3.

[2]Mallinson, George Greisen and Buck, Jacqueline V., "There Are Four Plant Phyla." *The American Biology Teacher*, XVI (May 1954), 109-11.

written. If the above description is characteristic of much experimental work in biology (and it is), then it would seem that the criticisms implicit in the first viewpoint are amply justified.

How may the inductive or problem approach be used? Here is an example.

A short time ago one of the authors attended a meeting of science teachers in Central Indiana. While exploring the local area, a pond was located that offered interesting possibilities for an exercise for his class in Methods and Materials in Biology. On the "shore" were a number of shells of a fresh-water mollusc native to the "Great Lakes" area. The water at the edge of the pond was covered with "fruiting" duckweed. Samples of both were taken back to Michigan. The following statements were made to the class:

"I have here some plant material that I skimmed from the surface of a pond in Indiana. (Here the general ecology of the area was explained.) I also found a pile of these shells on the bank. They may have been left there or they might be native to the pond. I'd like you to figure out this problem: 'Is it logical that both this plant material and this animal material would ordinarily be found in such a pond? Or is it more likely that someone had a 'clam bake' and these are part of a pile of garbage'?"

Actually, *this seemed* to constitute a problem. The students obtained microscopes, examined the specimens, made slides, checked botany books, and resurrected a discarded "key" on fresh-water molluscs from the biology storeroom. Of course some of the answers that emerged during the investigation were appalling. The shells were identified as being relics of an age when oceans covered Indiana, and possibly a fragment from the "tusk of a dinosaur." The duckweed was variously identified as fungus, liverwort, fern and filamentous alga.

However, as each answer (or opinion) was brought forward, the students were asked to justify it. The ridiculous natures of some answers were discovered by those who made them. Eventually, several students came forward with a sensible answer. The whole group then discussed the logic behind the answer. Actually this required two or three times as long to accomplish as the typical exercise. Yet, it seemed that vastly more was learned from this one exercise than from five typical ones. Further the students requested more of the same and several changed their major sequences to include another course in botany!

Nearly all teachers have at one time or another used preserved materials in the laboratory. Yet it is difficult to understand how a dead frog can be the focus of a real problem other than one of disposal. Hence at the high school level the following is suggested if one wants to use a frog in a meaningful laboratory exercise.

Pair off the students. Place a live frog in or under a large jar in which there is sufficient space for it to move freely. Directions may be given in this way:

"In many biology classes a frog is 'cut up' and examined because it is supposed to be similar in certain ways to the human being. That may be true. However, it's obvious that there are also many ways in which it is different. I want you to watch the frog and its behaviour for the next fifteen minutes. From your observations list as many ways as you can in which the frog is similar to the human being, and in which it is different." Thus the student is directed to a problem to which he must devote his attention. The answers cannot be copied from a book. The necessity for observation is obvious.

For those who prefer a problem that may be somewhat more academic, here is one that can be developed around a stalk of celery. A fresh stalk is broken but not separated. The ends are pulled gently until the "strings" are seen clearly. The group may be addressed in this way:

"We have been discussing monocots and dicots the last few days. However, there is lots yet to be learned. If you'll note, I have here some celery. (Prepare it as above.) I'd like you to do with your sample what I have done with mine. Then, try and discover, using any equipment in the room, exactly what part of the plant the strings are."

Obviously, a number of ramifications are possible. However, this avoids the approach, "Make a cross-section of the celery stalk and examine it under the dissecting microscope."

Early in the school year, one of the areas of biology usually covered is the distribution of life on the earth. Frequently this is accomplished with a film, or by showing pictures that illustrate the diversity of life.

One technique for developing this concept by means of the problem approach is to have students form groups of four or five. The groups are then told the following:

"I want each of the groups to move into some part of the area around school. (This of course is most successful in places where there is an open field.) I'd like each group to remove exactly one cubic foot of soil starting at the surface. Place it on the newspapers that you take from the pile in the front of the room. Then carefully separate the soil and see how many different kinds of plants and animals your sample contains. Keep a record of your observations."

At the end of the session the count of each group is compared with those of the others. In addition the types of soil and the types of plants and animals discovered by the different groups may be compared. In this way the variety and quantity of life as related to the type of soil may be studied.

The teacher of course can modify the themes described here to fit nearly any area or concept of biology. However, the important factor is to provide a situation in which the student must make some of the plans for carrying out the techniques needed to investigate the problem.

2. *If at all possible, present the laboratory work prior to classroom discussion rather than afterward.*

Many teachers express the viewpoint, "I'd rather present the laboratory work after we've talked about the material in class. The students seem to know what they're doing. They fumble around if they haven't learned it ahead of time."

The argument is eminently reasonable if the objectives of a biology course are (1) to prove through laboratory work that the teacher did not lie in the lecture, and (2) if only facts are to be learned and verified in the laboratory.

However, if problem-solving skills are objectives, the argument represents the epitome of invalidity. One can hardly expect a student to look with inspiration for something he already has. Further it is obvious that the student will quickly divert his attention to other matters. But then, why investigate in the first place if you already have the answer? The laboratory should be designed to develop skills in "looking for." Thus it should be presented before the student knows the answers.

3. *Study specimens in their natural environments if at all possible, rather than in the classroom.*

It is difficult to visualize anything more unrealistic or pathetic than a twig, covered with frog or salamander eggs, immersed in a battery jar of warm stagnant water. Probably the only situation comparable is the crayfish dying in a battery jar next to the above—or perhaps the willow twig mounted in formaldehyde.

Animals live in environments in which their characteristics enable them to make satisfactory adaptations. Hence their characteristics are intimately related ecologically with the environments. Unfortunately many students learn to recite the characteristics of species devoid of any environmental relationships. Hence when faced with a species in its environment, the student is unable to identify it.

Perhaps one key to the entire problem may be summarized in one or two sentences. Biology is a life science and should be taught as such. Too many of us teach it as though the laboratory were a mortuary!

POULTRY DISEASE AND LEUKEMIA

A fatal poultry disease, which resembles human leukemia—sometimes called cancer of the blood—has been shown to be associated with a virus by Joseph W. Beard, M.D., professor of experimental surgery at the Duke University School of Medicine. Dr. Beard emphasized that these studies did not attain the ultimate goal of determining the influence of viruses in cancer, but they were an important step in that direction. He discovered that this virus had the specific property of changing the character of a chemical called ATP (adenosine triphosphate). ATP is one of the most important sources of energy for muscle contraction and other physiological processes within the cell.

Back to the Green Kingdom

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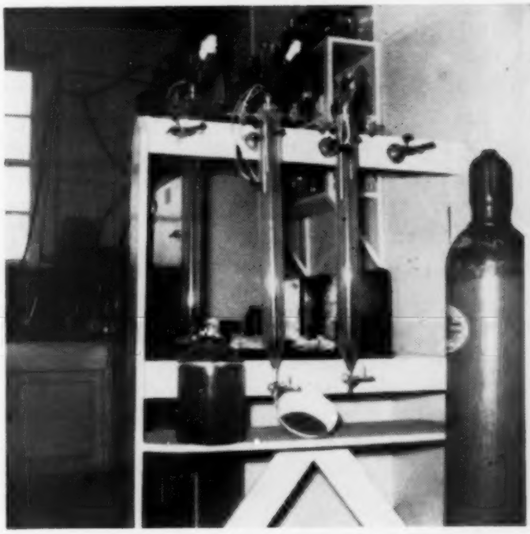
Oxidation Ponds. House contains centrifuge.



Algae-Bacteria Symbiocon. Dish of Algae Harvest.

Flying over the Golden Gate to a lonely strip of coast land, a Sea-Pigeon hovered over a yellow earthwork lagoon filled with lush green water so thick with billions upon billions of free-swimming algae that the plankton meadows could be outlined like a relief map. The dove-tail gull invited by the fragrant grassy odor swooped down, nibbled at the rich nourishment of the man-made oxidation pond and soared to a nearby rock. After resting a while on its bright red legs, it wheeled Pacificward in a sudden burst of energy.

On that amazingly nutritional nibble the seabird could fly many miles without diving under surface waters for its usual marine fare. For the algal meadows, with more than a goodly amount of the building blocks of protein, plus carbohydrates, plus fats and other vital nutrients, offer a rich, highly concentrated food.

From the pond it's a stone's throw to a drab grey wooden building where the sign, "Algal-Bacterial Symbiosis," points the way to a laboratory. Here you may learn at first hand that this unique food is the result of a strange partnership or symbiosis between algae and specially selected bacteria. These age-old organisms, both of whom could claim land priority in stepping from the mother arms of the ocean, work together in an exciting University of California technological project that has resulted in utilizing the sun's energy to treat sewage and at the same time produce a highly nutritious animal food.

It was in 1949 that two sanitary engineers of the University of California, William Oswald and Harvey Ludwig (now with the United States Public Health Service), and their chief, Prof. Harold B. Gotaas, former chairman of Civil Engineering and Irrigation, set up this laboratory to find out how algae could be utilized to assist in sewage treatment. The scientific trio have the distinction of coming up with the first comprehensive study of the controllable growth characteristics of the one-celled green algae in sewage. While the study of algae began sixty years ago in Holland, synthetic media largely have been used to grow algae for scientific observation.

The idea of producing food from photosynthesis carried out by the algae is not a new

one. Chemists have been experimenting in recent years with the ubiquitous algae as a source of synthetic chemicals for alcohols, paints, varnishes, and even substitutes for food. But this work has always been carried out with artificial inorganic media which means expensive nutrients. These, in contrast, are free for the asking in rich sewage media. For the bacteria break down the complex organic matter of sewage and release such vital nutrients as carbon dioxide, nitrogen in the form of ammonia, and phosphorous.

The algae take up the carbon dioxide and through photosynthesis make cell matter. So the pond effluent may contain as much organic matter as the sewage entering it. But there's a difference! The entering sewage solids are highly contaminated, but the algae cell matter is understandably stable because of the high content of oxygen.

This whole biological breakdown of sewage stems from the Algal-Bacterial Symbiosis. But it is a forced partnership rather than a natural one. For an example of a natural symbiosis one may take the tubellarian worm which gets its green color from the large number of unicellular green algae living as guests in its tissues. In exchange for a place to live, the algae supply a part of the oxygen for the parasitic worm's cells. Another instance shows bacteria and legumes, such as peas and beans, profiting from a partnership where bacteria receive protection and carbon compounds from its host, the legume, which, in turn, receives fixed nitrogen from its bacterial guest. Still another instance is that of an alga and a fungus living together aiding one another. The alga reduces carbon dioxide to form carbohydrates for itself and the fungus. The latter, unable to make food, conserves moisture and makes minerals available to both partners.

But the algal-bacterial symbiosis is more like a fifty-fifty proposition where each organism is forced to be dependent upon the other to the mutual benefit of both. The phenomenon of bacterial oxidation of sewage and photosynthetic reduction of bacterial-end products may be compared to a balanced aquarium where plants and fishes work for the good of each other. In other words, the bacteria break down the vital nutrients of sewage, and the algae convert them into new cell matter or food.

The algae formed this vital partnership with bacteria in a culture tube especially designed by Oswald, director of the "lab." He called it a symbiocon, a word you won't find in the dictionary. He especially coined the name for this vertical glass tube which provides an environment where the algae can be controlled and where everything can be measured without disturbing the culture.

For this algal-bacterial symbiosis, Oswald selected a single algal species, *Euglena gracilis*, a motile member of the Eugleninae family. Although Euglena, neither plant nor animal, is not the only alga used nor by far the fastest grower, it is a prodigious multiplier, growing by leaps and bounds in polluted waters.

This one-celled plant-like animal contains chlorophyll and essential enzymes with which plants in sunlight transform lifeless chemicals into living tissues. As presently understood, the chlorophyll in the algae splits the water leaving the hydrogen free within the cell. The oxygen is freed from the cell but the hydrogen is used to combine with carbon dioxide to form new cell materials which contain more than 50 per cent protein, 35 per cent carbohydrates, 5 per cent fat and other life-giving nutrients.

When I looked into the microscope at the lab where Bill Oswald had placed a streak of Euglena, the invisible mass of green jelly suddenly came to life. Trapped in the Lilliputian city, the unhappy Euglena, changeable as chameleons, whirled round and round. I watched one in particular as it changed quickly in size, shape and brilliance. Long and narrow and green one second, it somersaulted into a gourd-like shape sparkling with yellowish tints. Fiercely it lashed the water with a single hair-like flagellum as it steered clear of a tulip-shaped Vorticella which looked gigantic in this miniature water community.

In this amazing green kingdom, Oswald tells us that there may be millions of cells per cubic centimeter. He points out, "A great amount of potential energy is being stored up in each minute volume. When multiplied millions of times in the sewage flows of the great cities, one may realize the immense possibilities of the green algae for economic reclamation of organic matter."

Working alone in his laboratory at Richmond, California, a field station for the University of California, Bill Oswald performed the first completely controlled experiment of algae in sewage. At the the start portions of settled sewage were filtered through cotton, composited, pasteurized and bottled and stored at low temperature in the dark. He placed some of the bottled sterile sewage in the vertical glass tubes. He seeded it with bacteria to break the rich organic matter into carbon dioxide and ammonia. Later he inoculated into the solution a bit of algae culture which originally came from a California lagoon.

The temperature of the culture was maintained constant at 25°C by a heat-exchanging pipe placed within the culture. A train of bubbles mixed the cultures to keep the algae in suspension. Light was provided for the algae by controlled amounts of fluorescent light—three tubes supplying an intensity of 1200 foot candles to substitute for sunlight. For a precarious seven days the tube remained colorless.

Under the microscope the algae population steadily decreased. The experiment appeared to be a failure. On the sixth night two of the fluorescent lights went out. The next day the microscopic count of algae cells indicated an increase. There had been too much light!

Under the weak illumination of a single light gleam the population increased and then some. On the tenth day the culture was visibly green. This meant that the young motile cells with a high percentage of nitrogen were liberating the oxygen needed for respiration of the sewage oxidizing. Too, they were growing rapidly, producing more and more oxygen, which, in turn, permitted the survival of greater amounts of bacteria. The algae production accordingly stepped up the rate of decomposition.

Besides light and temperature, retention played a most important part in the production of desirable "young cells." A retention period ranges from 1 to 20 days. But the shorter the retention period the better for the younger and greener is the cell-matter. Longer retention periods mean a shortage of one or more nutrients so that cell counts become progressively slower. The "old cells" yellow because of a lack of chlorophyll change into forms of low metabolic activity. They grow very slowly and produce less oxygen than they respire.

On the other hand, during shorter retention periods, the "young cells," small, dark green, highly motile, are growing rapidly on an abundance of nutrients. They photosynthesize much more oxygen than they respire. And they cannot become old until the streams are clean and free of pollution. Thus, the "young cells" thrive best in polluted streams where oxygen is critically needed. Also, they are surprisingly steadfast.

From this multiplicity of young cells a pea-green culture forms in the tube. This culture is separated from the supernatant liquid by centrifuging followed by drying. When dry the algae forms a highly concentrated flake-like green powder. So complete is this revolutionary conversion that the product tasted to me like a favorite breakfast food.

The experiment with direct sunlight falling on the man-made oxidation pond for photosynthesis, is now entering a pilot scale. A faucet at one end brings a flow of domestic sewage taken from a sewer line pumped through a settling tank where the sewage is pretreated by sedimentation to remove large pieces of fresh organic matter. As the settled sewage enters the oxidation pond, it is teeming with bacteria. The sewage which has a putrid odor could be a health hazard. In contrast, the self-purifying algae are highly stable and offer no pathogenic significance. In fact, the algae eliminate the health hazard, because of their high oxygen content.

The pond cultures are started in sewage from a tiny speck of algae on a needle. By diluting the original culture and placing the surplus in additional flasks, many gallons of culture are produced in a few days. When about twenty-five gallons of culture are prepared, this is emptied into the pond to start the process. More sewage is added which is mixed with the cultures. The algae grow rapidly. In fact, the faster the sewage is put through the process, the faster the algae grow. And the resulting greater oxygen means faster sewage treatment. And since the tremendous cost of sewage treatment lies in supplying oxygen, it is easy to understand why the treatment of sewage by way of algae purifica-

tion in the colossal sewage disposal plants will offer great savings.

Incidentally, Oswald states, "that present techniques of disposing of municipal sewage take approximately 35 acres of space to handle a million gallons of sewage per day. Our algae farm will probably handle a million gallons on six acres of land and in addition will yield about 1000 pounds of food-algae per day."

Besides the valve which brings in the sewage, another pours the purified sewage into the San Francisco Bay. A third valve takes the algae cells into the separator by transparent tubing which leads into a stainless steel bowl-shaped dish containing a strainer to remove insects. The green cell food here is quite dilute. But it is concentrated by cycling through the separator a number of times.

The resulting dark green paste goes into a separate container to be dried. The liquid comes out as a clear supernatant charged with oxygen. The practically odorless supernatant is pumped into the bay. The other pump leading from the centrifuge pours the green food into a small bowl which foams with the mixture of algae and air, like foam on a milking pail. From there the foaming algae flow into a retaining flask. It is now ready for drying into the flaky, finished product.

The centrifuge, however, is not economically feasible for commercial use. Meanwhile, studies to devise a successful harvesting technique are continuing. At present, Oswald is working on a promising lead which will make the green flaky powder even lower than its present estimate of 20 cents a pound. This is lower than the algae food resulting from synthetic media with expensive nutrients added. Cats, dogs and chickens readily eat the rich proteinized food without any ill effects.

In addition, the process could aid in purifying streams and reducing the expenditure of millions of dollars which are now needed to reasonably reduce the pollution of the United States water supply.

Algae, currently being hailed as the world's richest source of food, may through its direct contact with the sun supplant "fossil sunshine" which we know as oil and coal, and which are approaching the point of no return.

Carbon Tetrachloride in the Biology Laboratory

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Besides the common use of carbon tetrachloride as a solvent and for cleaning, the laboratory has many special uses for this familiar fluid. Of course, the use of carbon tetrachloride in insect killing bottles is well known. The lethal effects of its gas on insects and its comparative safety around human beings has popularized it above the standard cyanide killing bottle which has long been used by biologists. The obvious disadvantage of the cyanide bottle is the extremely toxic nature of cyanide to all living organisms. To be more specific about carbon tetrachloride as a killing agent for insects, it is as poisonous for mammals as it is for insects under similar conditions. Its killing power is simply, that as a very volatile gas, it evaporates quickly. The gas is heavier than ordinary air so that in a closed space (such as a killing bottle) the carbon tetrachloride gas quickly fills the bottom of the bottle, floating the oxygen-containing air above it. An insect put into this bottle drops below the surface of a sea of gas which does not provide the oxygen needed for respiration. This is essentially the reason why carbon tetrachloride fire extinguishers are effective. They blanket the area with a non-flammable, non-combustion-supporting gas, and the fire goes out. The insect dies for want of oxygen just as the fire goes out in the absence of oxygen.

The effects of carbon tetrachloride are essentially the same on mammals as on insects under similar conditions. In a closed area the oxygen-lacking gas will kill mammals as well. Because of this fact, reasonable care does need to be taken when using carbon tetrachloride around human beings.

The problems of killing small animals captured in wire traps has long been vexing trappers. Disposing of the animal by any way which leaves an odor on the trap may hinder the further usefulness of the trap. The shooting of animals in traps is discouraged for this reason. An alternative is to submerge the trap in water and drown the animal. The carbon tetrachloride method is better than either since

a box big enough to hold the trap is all that is needed. A common cardboard box of grocery store origin is adequate. A cloth dampened with two tablespoons of carbon tetrachloride placed in the box with the trap will kill the animal quickly and humanely, and will leave no odor on the trap which will be objectionable to other animals. Only a few minutes are required and the animal is dispatched.

Incidental to the killing of trapped animals, especially rats, is the fact that this method also kills the ectoparasites which are on the rat at the time of capture. A rat killed recently at this laboratory was carrying a dozen rat fleas, *Xenopsylla cheopis*. The fleas were dead on the bottom of the box when it was opened. This has been the easiest method we have found for obtaining rat flea specimens.

Another related use in the laboratory is cleaning of cages that have become infested with lice and similar parasites. Bird cages, for example, can hold many lice while repeated dosing of the bird with lice powder has little lasting value. One sure method is to remove the bird from the cage and put louse powder on the bird. Placing the cage simultaneously in a box containing a cloth with a little carbon tetrachloride will effectively kill the parasites in the cage while those on the bird are being attacked by other means. Lice hiding in the crevices of the cage are more easily killed by this method than any other we have tried.

Carbon tetrachloride can also be used as a substitute for chloroform in dealing with some laboratory animals. No complicated killing box is necessary although some laboratories go to extreme ends in gadgetry for such a box. Actually all that is needed, again, is simply a cardboard box just big enough for the animal that is to be killed. A little carbon tetrachloride is placed on a cloth and the box closed. The humane manner in which carbon tetrachloride acts as well as its speed is reason enough for its adoption in the laboratory as a general lethal agent.

Potent new chemical killers of amebae which can cause dysentery and related diseases in man have been developed through recent laboratory research. Amebiasis is said to be a serious medical problem in such countries as South Africa and Indonesia. New drugs are an urgent necessity in the fight against this disease.

Biology Clubs and Projects

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Current educational objectives include the permissibility, if not mandatory acceptance, of school clubs as a valid educational teaching medium. Despite this, how may biology teachers use this agency to develop the biological interests of their students? An examination of our science education journals indicates too few of the nation's biology teachers sponsor clubs. Certainly the number reported is far out of line in comparison with our secondary school biology enrollment.

Statisticians list the current high school population at six and three-quarter million and estimate this number will increase to approximately ten million by 1960, and twelve million by 1965. Other studies point to the secondary biology class and club enrollments. Johnson (1) found that during the first term of 1947-48 a number equal to 74.9% of the tenth grade pupils were enrolled in biology. Martin (2) reported that about 59 per cent of a selected group of schools, which offered biology on the tenth grade level, had 76 per cent of the tenth grade pupils enrolled in biology. Dr. Martin's study also shows that out of 786 schools studied, only 33.5 per cent reported clubs. In addition, he states, "Large high schools reported science clubs much more frequently than did small high schools. For those pupils who were enrolled in high schools with enrollments under 100, opportunities to engage in club activities were practically non-existent." Davis (3) gives us this picture: "In more than 14,000 junior and senior high schools there are these clubs, each with a couple dozen members who have as their guide and sponsor a favorite science teacher." For comparison there are 24,000 public high schools in the United States. A study of these figures reveals that we are not reaching, nor nearly reaching, the limits of possibilities for training America's secondary school students in biology through biological club activities. Eligible secondary school students who have never enrolled in a biology course must be listed on the debit side of our education ledger.

Biology clubs may be organized with a view of attaining many objectives. Basically, the club should bring together those students who are most interested in promoting an effective outlet for accomplishing their biological interests. The club's over-all type of program, specific problems within the program, necessary equipment, field trips, project activities, speakers, exhibits, publications, social activities—these are the factors which outline the definite procedures of work. After the program pattern has been selected and begun, care must be taken that the very desire to attain success should stimulate the club's members to work with enthusiasm. Ideally, the club should be representative of all things for which a modern youth organization should stand in America.

If the club is to accomplish positive results with students, the adviser must not dominate their thinking and actions. On the other hand, it would be equally unwise for the teacher to withhold the benefits of his broader training and experience. During the early stages of the club's formation, the teacher should take an active, interested part in organizing and directing the group. This should be done, in the main, through suggestion rather than precept. As the members mature in experience, they may be given more opportunities for taking the initiative. At all times the members should be convinced that the work of the club is important to them.

Human nature has many susceptibilities. An individual's interest can be raised to a higher degree when it becomes a coefficient of group stimulation. This objective can be accomplished when the adviser exhibits a genuine, friendly, optimistic, interested attitude toward the club's members and their problems.

One of the outstanding values of a club lies in getting pupils away from the sole use of a textbook and giving them the opportunity to work with their hands and with their minds, both alone and in cooperation with fellow students. Teacher preplanning and pupil-teacher planning of project activities are excellent for attaining this aspect of the program. While the construction of projects is a temporary phase of a student's academic life, their meaning is permanent, often expansive through increments which further self growth. Consequently, this mode of teaching and learning is popular with teachers and pupils alike. The favorable climate of this judgment is evidenced by the increasing number of science fairs, science talent searches, publications, and science educational conferences by and for young people.

If students are to receive full benefit from their experiences with projects, it is axiomatic that they acquire a plethora of information about the problem which they have undertaken for solution. They should be intelligently aware of the following four factors: 1. They must know what they want to do. 2. Is the solution of their problem possible of accomplishment by them? 3. They must know how their problem can and should be solved. 4. Upon completing their projects, the pupils should recognize or sense accrued values.

In this sphere the adviser can contribute by aiding students to find problems which interest them and by guiding their thinking to the desired solution. Also, the adviser can make available, needed material which might otherwise be difficult for student procurement.

Club members may be encouraged to construct needed laboratory equipment as a part of their program. If, however, the construction of apparatus is the end sought, with no other motivating influence, the project idea is not accomplishing its full purpose. Undoubtedly, the biology department can benefit through the acquisition of usable equipment. In almost every class at least one individual will be found who has a special skill. This talent can and should be used to the department's advantage. Primarily though, the project should be a component of the biology student's learning process; useful in channeling student inquiries and actions into fruitful approaches to his biological training.

It is always a source of encouragement to young people when they know their completed projects will be used constructively. There are a number of outlets for demonstrating this. The list which follows is suggestive of ways: 1. A school assembly program offers an excellent opportunity for displaying outstanding student work. 2. Exhibits may be displayed in school corridor cases, school and city libraries, museums, colleges, and educational conferences. 3. Suitable student projects should be used in the regular class work. 4. Projects may be used to stimulate student participation in science fairs and talent searches.

I recommend: 1. That the NABT take positive action to encourage more schools, particularly schools with the smaller enrollments, to organize biology clubs. 2. That the NABT seriously consider the formation of a committee to prepare, for publication, a brochure covering the best practices in biology clubs and project work.

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3. Davis, Watson—"*Science Teaching Can Be Fun*." The Western Illinois State College Bulletin. Vol. XXIX, No. 1. May 1949.

Club and Project Publications

1. Special Biology Club Issue—"*The American Biology Teacher*." Vol. 4. No. 6. March 1942.
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3. Hollenbeck, Irene and Stevenson, Elmo,—"*Selected Procedures in Teaching Biology*." 1950. Oregon State College, Corvallis.
4. Mallinson, George G.—"*Sponsoring The Science Club*." Series 11, No. 1. April 1950. Western Michigan College of Education, Kalamazoo.
5. Catalog of Exhibits Greater St. Louis Science Fair. Sponsored by the St. Louis "Star-Times."
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Photography in the Classroom

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To make the unit on light and photography a more widening experience for the pupils in my general science classes at Wilson Memorial High School, I took advantage of Eastman Kodak's "slow" Velite printing paper that allows pictures to be printed in a lighted room. The exercise created much interest in the classes, and the expense was not great. Detailed instructions for presenting the unit are given here in hope other teachers might make use of this teaching aid.

The materials used in the unit for a class of 36, working in groups of 7 or 8 pupils, were obtained from three sources: the homes of the pupils; the school laboratory; and Sears, Roebuck mail-order house. The materials purchased from Sears, Roebuck were:

1. Kodak Universal MQ Developer at a cost of about 30¢ for a package of six "batches" of developer. Each batch is suitable for one group and is discarded after each class.
2. Tower acid short stop at a cost of about 30¢ for powder to make two gallons of solution which can be used over and over.
3. Kodak Acid fixing powder (commonly called hypo) at a cost of about 20¢ for powder to make 1 quart of solution that can be used over and over.
4. Velite paper in the 100 sheet package for about $1.10 is about 2½ by 4½ inches in size and was cut in two pieces for easier handling and to make the paper go farther.

The other materials used were:

1. old newspapers;
2. three beakers, water glasses, cereal dishes, or other glass containers capable of holding 1 cup of solution;
3. a measuring cup and stirring rod of glass;
4. two clear glass plates (lantern slides work well);
5. two snap clothespins;
6. a lamp or drop cord with a 100 watt bulb that can be turned off and on when necessary;
7. a dish pan or large bucket;
8. a cloth towel;
9. a negative. Each pupil was asked to furnish his own. Some pupils brought their cameras to school the week before our unit and took pictures to be developed in the school dark room or at the drug store, then used those negatives.

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Biology in the News!

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LIKE OLD TIMES, Arthur Grahame, *Outdoor Life*, Jan. 1955, pp 50-51, 112-119.

How a group of public minded citizens changed a portion of the old Lehigh Canal into an area for fishing, hunting and other types of recreation. Your conservation minded students will enjoy this.

YOUR EMOTIONS CAN KILL YOU, Maurice Zolotow, *Cosmopolitan*, Jan. 1955, pp. 14-19.

No where are you more at the mercy of your feelings than when you are driving an automobile. Emotions can warp your judgment just enough to cause serious accidents.

A NEW WAY TO CURB DANGEROUS DRIVERS, David Landman, *Redbook*, Jan. 1955, pp. 34-37, 84-86.

How can we find the potential killers who drive automobiles? This article discusses the problem and offers some very practical solutions which are being used.

PAIN IN THE NECK, Maxine Davis, *Good Housekeeping*, Jan. 1955, pp. 38,182.

Pain in the neck can be a symptom of a serious illness, a hidden injury, nervous tension, or the result of poor posture or a chill.

PUSH BUTTON TOMATOES, Ed Ainsworth and John W. Hilton, *Collier's*, Jan. 7, 1955 pp. 46-47.

A short account of some unusual ways to grow plants which are being used to solve the mystery of growth.

THE DOCTORS WHO REBUILD LIVING HANDS, Valeda von Steinberg, *Sat. Ev. Post*, Jan. 8, 1955, pp. 36-37, 56-58.

Hands are frequently damaged. Orthopedic surgeons have developed marvelous techniques to restore many digits to useful function.

FOOD, *Life*, Jan. 3, 1955. An entire issue devoted to food. Almost all aspects of production processing, marketing and consumption are described. This issue must be seen to be appreciated. You need several copies of this issue.

HE MAKES OPERATING ROOMS SAFE, *R.* M. Cunningham, Jr. and Greer Williams, *Sat. Ev. Post*, Jan. 1, 1955, pp. 9-11, 47-48.

An account of the activities of Dr. Carl Walter who crusades for greater safety in operating rooms, especially in matters of surgical cleanliness. His life account may be an inspiration to others.

COLD CAN SAVE YOUR LIFE, Ben and Marie Pearse, *Sat. Ev. Post*, Dec. 4, 1954, pp. 35, 108-110.

Ordinary ice water can make a man insensitive to pain, slow his bleeding, and make it possible for surgeons to perform perilous operations with greater safety.

SHOULD BLOOD MAKE MONEY?, Bill Davidson, *Collier's*, Nov. 12, 1954, pp. 34-40.

The American Red Cross and most doctors say they should not. But prices for blood range from nothing to as much as the person can afford. The arguments for and against charges for blood could set off some hot arguments among the students.

TRAVELING TRAPPER, Walt Wiggins, *Outdoor Life*, November 1954, pp. 58-63.

A pictorial account of a trapper employed by the U. S. Fish and Wildlife Service who destroys coyotes, bobcats and other predators. This might arouse discussion about the ecology of predator control.

AN EXPERT ANSWERS 37 MOST-ASKED QUESTIONS ABOUT CANCER, *Cosmopolitan*, November 1954, pp. 114-119.

The content is well described by the title. This is worthwhile reading for all your students.

DR. KALLMAN'S 7,000 TWINS, Morton M. Hunt, *Sat. Ev. Post*, Nov. 6, 1954, pp. 20-21, 80-82.

Is insanity inherited or does the environment cause it? Twins, both fraternal and identical, are being studied in an effort to find the basic reasons for mental disease. For your more advanced students.

THE MARVELS OF OUR MUSEUMS, *Collier's*, Nov. 12, 1954, pp. 78-83.

A pictorial account of some of the fossil remains of our prehistoric animals which may be found in the museum. Good bulletin board material.

(Continued on page 113)

PHOTOGRAPHY

(Continued from page 111)

When each group had the necessary materials before them, they were given verbal instructions slowly enough to allow them to complete each step as it came. In order to become familiar with the terms and general procedure, I had them write out, in their notebooks the day before, the same instructions found below. The reason for giving verbal instructions, rather than have the pupils use their notes was to keep the entire class together, so we could finish the unit in an hour. The pupils followed the instructions very well and I had better class attention that day than any other day during the school year. The steps are simple.

1. Spread the newspaper over the desk so solutions, if spilled, will not soil the desks or books.
2. Place the beakers (or other containers) in a row in front of you and mentally number them 1, 2, and 3 from left to right.
3. Pour 1 cup of water into beaker 1. Break open the "A" powder into the water and stir until it is all dissolved (about 1 minute). Break open the "B" powder into the water and stir until it is all dissolved. This is the developer.
4. Pour 1 cup of the stop bath from the stock bottle into beaker 2. This is to stop the action of the developer, so never let any of the stop bath get into the developer.
5. Pour 1 cup of the hypo from the stock bottle into the beaker 3. This is to fix the picture so it will not fade. The hypo must not be put into the developer.
6. Fill the pan or pail with clear water and place beside the hypo.
7. Connect the lamp so it will turn off and on when you need it. Turn it off. Pull the blinds at the windows to shut out as much daylight as possible. The overhead room lights may be left on so you can see what you are doing.
8. Examine the negative. Notice that it has a dull side and a slick shiny side. Place the negative on a piece of glass with the slick shiny side down against the glass.
9. Open the Velite paper box, remove 1 sheet of paper, and quickly close the box. Examine the paper quickly and notice it has a dull side and a slick, shiny side. Place the slick, shiny side against the negative.
10. Quickly put the second glass plate over the paper and clip the glass plates together with the clothespins. Do not get the clothespins over the negative.
11. Hold the glass plates about 1 foot from the light bulb with the negative toward the bulb. Turn the bulb on and count *slowly*, "one-hundred one, one-hundred two, one-hundred three," etc., until you reach "one-hundred twenty." Turn the light off.
12. Remove the paper from between the glass plates and place it in the developer. When the picture is as clear and dark as you like (about 1 minute) remove it and quickly place it in the stop bath (beaker 2).
13. Take the picture form the stop bath after 15 seconds (or longer, but never less) and place it in the hypo.
14. Take the picture from the hypo after 10 to 15 minutes and place it in the bucket of clear water where it should remain for 12 to 24 hours. (Teacher should change the water once or twice during this period.)
15. Take the pictures out of the water and place them between a folded towel. Let them dry for 6 to 12 hours.

BIOLOGY IN THE NEWS

(Continued from page 112)

THEY DID NOT MEAN TO KILL, Ashley Halsey, Jr., *Sat. Ev. Post*, Nov. 6, 1954, pp. 24-25, 69-70.

Over 2,000 Americans a year are accidentally killed by bullets. More than a third of the dead are youngsters. This article recounts some of the stupid things people do, and makes useful suggestions for the protection of your family.

SCHIZOPHRENIA, Ruth and Edward Brecher, *Cosmopolitan*, November 1954, pp. 22-25.

Schizophrenia is one of the commonest mental disorders. Its causes and manifestations are discussed together with those flashes of fantasy experienced by normal people. For your more advanced students.

Books for Biologists

THE EARTHWORM. THE FROG. THE HUMAN. Dr. Albert Wolfson, Associate Professor of Biology, Northwestern University, and Arnold Ryan, Scientific Illustrator, Evanston, Illinois. Unitexts in biological science. Page size of each book: 6½ x 9½ inches. Number of acetate pages of "dissection": 8 in each book. Total number of pages of instructional material, including text, drawings of dissections and special graphic features: 34 in *The Earthworm* and *The Human*; 26 in *The Frog*. $3.20 each. Row, Peterson and Company, 1911 Ridge Avenue, Evanston, Illinois. 1955.

Each book contains a series of acetate pages of accurate drawings (front and back views in real-life color and true perspective.) These pages make it possible to "dissect" the specimen by turning the page (removing a layer). In this manner, the frog and human are stripped away from ventral to dorsal sides, while the earthworm is dissected from the left side. The whole visual story is shown as it would appear in a perfect laboratory dissection, with the advantage of having every anatomical part keyed to accompanying text for easy identification. Text matter and special graphic presentations of biological concepts are included.

THE DISTRIBUTION AND ABUNDANCE OF ANIMALS. H. G. Andrewartha and L. C. Birch. 782 pp. $15.00. The University of Chicago Press, Chicago 37, Illinois. 1954.

An animal ecology book which asks the fundamental question: How does environment influence the animal's chance to survive and multiply? The search for an answer leads, on the one hand, to an examination of the animal's physiology and behavior and, on the other, to the four basic components of environment: weather, food, other animals, and a place in which to live. There are, in addition, special chapters on the genetic aspects of ecology and a section which reviews critically seventeen major studies of natural populations, as a means of illustrating the methodology and principles of analysis which the authors have employed.

THE SOCIAL INSECTS. O. W. Richards. 219 pp. $4.75. Philosophical Library. New York. 1953.

One of Britain's most distinguished entomologists describes, with illustrations, many interesting facts about the behavior of social insects such as wasps, bees, ants, and termites.

CAREERS AND OPPORTUNITIES IN SCIENCE. Philip Pollack, with an introduction by Dr. Harlow Shapley. 252 pp. $3.75. E. P. Dutton and Company. New York. 1954.

This book is a completely revised and rewritten version of the author's earlier book, *Careers in Science*. It is designed especially for boys and girls of high school age. Information is provided about work in agriculture, conservation, physics, chemistry, astronomy, meteorology, aviation, and many other areas. A survey is given of the time involved, intellectual requirements needed, and the expenses incurred in each area of preparation.

PUBLIC EDUCATION AND THE FUTURE OF AMERICA. Educational Policies Commission, 1201 Sixteenth St., N.W., Washington 6, D. C. 98 pp. $1.50. 1955.

Chapters include: Public Education and Some Great American Principles; The Foundations of Universal Public Education; Toward a Universal Common School; Toward Equality of Educational Opportunity; How Public Schools Have Served the American People; Education in an Era of Decision; and Public Education and the Future of America.

ATTRACTING BIRDS TO YOUR BACKYARD. W. J. Beecher, former president of the Chicago Ornithological Society. 63 pp. $1.00. All-Pets Books, Inc. P. O. Box 151, Fond du Lac, Wisconsin. 1955.

The bird lover is provided with the information necessary to properly equip his home to attract and identify wild birds all year round, regardless of whether he lives in city, suburb, or subdivision. Illustrated.

FELLOWSHIPS FOR TEACHERS

Cornell University has received a DuPont grant to stimulate better science teaching in the high schools. One group of fellowships has been established to give full tuition and $1200 toward expenses of science majors taking courses leading to certification for secondary school science teachers and a master's degree. A second group of fellowships will cover full tuition and certain expenses for secondary school science teachers who wish to use the 1955 Cornell summer session for advanced work. Dr. Philip G. Johnson of the School of Education is in charge of the program.

"There is an often accepted idea that recognizing each other's differences would stand in the way of understanding brotherhood," Dr. Roger Williams, famed University of Texas biochemist, says. "Quite the opposite is true. The greatest difficulties between people arise when they fail to recognize each other's individuality and try to impose their own tastes in reading, amusements, religion and politics on one another." Dr. Williams proposed the name "chemical anthropology" for this science of the study of individual differences.